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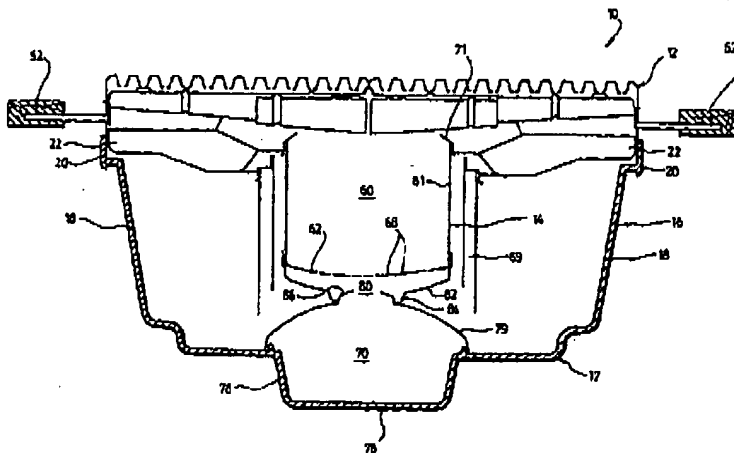
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(54) Title: BURNER FOR A COOKING APPARATUS



(57) Abstract

The burner (14) for a cooking apparatus (10) comprises a combustion chamber (60) bottomed with a diffuser plate (62), the diffuser plate (62) having openings (68) therethrough. An air-receiving chamber (70) in fluid communication with the combustion chamber (60) via the diffuser plate (62) is provided. The air-receiving chamber (70) has an air inlet (72) for connection with an air pump means (74) for forcing air through the openings (68) of the diffuser plate (62) so as to cause the air to exit on the upper surface thereof in the form of small jets of a given velocity. The burner (14) is characterized in that it further comprises a dynamic air chamber (80) topped with the diffuser plate (62). The dynamic air chamber (80) has a bottom wall (82) provided with a funnel-shaped inlet (79) in communication with the air-receiving chamber (70) for receiving an air flow of a given velocity from the air-receiving chamber (70) and increasing said velocity to thereby create an air turbulence zone below the diffuser plate (62). The burner (14) provides dynamic combustion at low pressure and therefore consumes less energy than prior art burners.

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BURNER FOR A COOKING APPARATUS

FIELD OF THE INVENTION

5 This invention relates to a burner for the combustion of fuels such as wood, coal, oil, etc. and more particularly to a solid fuel burner which results in a highly efficient conversion to usable energy while minimizing unburned, pollution producing by-products.

10 BACKGROUND OF THE INVENTION

In reference to the applicant's previous US patents No. 4,924,847 and 4,747,781 describing a combustion system for initiating and promoting combustion where combustion was achieved with air under pressure through openings in a diffuser plate, the present invention relates to a new improved combustion system that provides dynamic combustion at low air pressure. Referring to figure 6, a prior art diffuser (100) and burner (102) for a combustion system as described in US patent
15 no. 4,924,847 and 4,747,781 is illustrated. The diffuser (100) includes a diffuser plate (104), a lower plate (106) and side walls (108), the combination forming a type of manifold. The diffuser plate (104) is provided with a plurality of small openings (110)). The bottom of the diffuser (100) is fitted
20 with a conduit (112) thereby creating a type of manifold having an input by means of the conduit (112) and an output through openings (110) in the diffuser (100). The opposite end of the conduit (112) is connected to a source of air such as an air pump (114). In operation, as described in US patent no.
25 4,924,847, a source of fuel such as a piece of wood or coal is placed on the surface of the diffuser plate (104) in the combustion chamber (116) of the burner (102). Ignition of the wood is initiated by igniting a suitably positioned supply of paper or other readily combustible material. After ignition,
30 temperature is established, the air pump is turned on, and air is forced through the conduit and out of the diffuser (100) through openings (110) in the diffuser plate (104). Combustion

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of the wood follows virtually instantaneously and is prompted by the jets of air, with identified arrows, exiting through openings (110) in the diffuser plate (104).

5 Considered as an old fuel for a long time and sometimes forgotten, biofuel is becoming again a very interesting fuel as it is not only renewable, the time to produce fuel being from a few months to a few years, but unlike fossil fuel, where fuel has been accumulated through time, it does not and will not create that environment and climatic instability created
10 by the use of fossil fuel. It is with that spirit in mind that this invention is presented. The present system is specially adapted to burn chunks or pieces of wood or similar byproducts of the biofuel family.

15 From the original patent, major applications of the burner were the integration of the system to portable products where batteries were the power supply for the air blower. The operating autonomy of prior art combustion systems is in general short, therefore, many batteries are required and the whole thing may be expensive.

20 The following references describe other examples of prior art burners: Japanese patents nos 52-45740 and 55-68506; US patents nos 3,635,651; 3,635,644; 4,184,456; 3,492,986; 1,983,709; 739,491; 4,377,153; 4,504,218; 3,170,504; 3,885,907; 4,248,586; 4,309,948; 1,731,053; 2,663,366; 3,954,387;
25 4,063,873; 4,674,973; 1,782,229; 4,639,213; 3,810,732; 3,870,459; and 1,552,365.

SUMMARY OF THE INVENTION

30 An object of the present invention is to propose an improved burner that provides dynamic combustion at low pressure and therefore consumes less energy than prior art burners.

35 In accordance with the invention, that object is achieved with a burner comprising a combustion chamber bottomed with a diffuser plate, the diffuser plate having an upper surface adapted to support a source of fuel, a lower surface and spaced-apart openings therethrough.

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5 The burner further comprises an air-receiving chamber in fluid communication with the combustion chamber via the diffuser plate, the air-receiving chamber having an air inlet for connection to an air pump means for forcing air through the openings of the diffuser plate so as to cause the air to exit on the upper surface thereof in the form of small jets of a given velocity.

10 The burner is characterized in that it further comprises a dynamic air chamber topped with the diffuser plate, the dynamic air chamber having a bottom wall provided with a funnel-shaped inlet in communication with the air-receiving chamber for receiving an air flow of a given velocity from the air-receiving chamber and increasing said velocity to thereby create an air turbulence zone below the diffuser plate.

15 The present invention also relates to a cooking apparatus comprising a burner as described hereinbefore, a grill assembly mountable above the burner and a support to support the grill assembly above the burner.

20 A description of a cooking apparatus incorporating a burner according to a preferred embodiment of the present invention will now be given in details with reference to the appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

25 Figure 1 is a cross-sectional side elevational view of a cooking apparatus including a burner according to a preferred embodiment of the present invention.

Figure 2 is a cross-sectional front elevational view of the cooking apparatus of figure 1.

30 Figure 3 is a perspective view of the burner of figure 1.

Figure 4 is an exploded side elevational view of the burner of figure 1.

35 Figure 5 is a cross-sectional view of another version of a dynamic air chamber which may be set under the diffuser plate of the burner of figure 1.

Figure 6 is a cross-sectional side elevational view of a prior art burner of a combustion system.

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DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to figures 1 and 2, the cooking apparatus (10) such as a portable stove including a preferred embodiment of a burner (14) according to the present invention is illustrated. The cooking apparatus (10) in a general manner comprises a grill assembly (12) with handles (52), a tubular burner (14) and a support to mount the grill assembly (12) over the burner (14). The support preferably consists of an open container (16) adapted to receive therein the burner (14) in an upright position. The container (16) has sidewalls (18) each having an upper edge (20) adapted to receive and support a corresponding outer edge (22) of the grill assembly (12) such that the grill (12) is mountable over the burner (14) which is enclosed in the container (16). More particularly, the upper edge (20) of each of the sidewalls (18) defines an L-shaped shoulder on which a corresponding outer edge (22) of the grill (12) is resting.

The burner (14) is made of a heat-resistant material preferably stainless steel. Referring also to figure 3, the burner (14) comprises a combustion chamber (60) bottomed with a diffuser plate (62). The combustion chamber (60) preferably has a cylindrical side wall (61). The diffuser plate (62) has an upper surface adapted to support a source of fuel, a lower surface and spaced-apart openings (68) through the diffuser plate (62) which preferably define a latticed pattern of openings, as best seen from figure 3. The source of fuel is preferably wood.

An air-receiving chamber (70) is in fluid communication with the combustion chamber (60) via the diffuser plate (62). The air-receiving chamber (70) is fitted with a conduit (72) thereby creating a type of manifold having an inlet by means of the conduit (72) and an output through openings (68) in the diffuser plate (62). The opposite end of the conduit (72) is devised to be connected to a source of air such as an air pump (74) for forcing air through the openings (68) of the diffuser plate (62) so as to cause the air to exit on the upper surface

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thereof in the form of small jets, represented with arrows, of a given velocity.

Referring also to figure 4, the burner (14) may comprise a shield (69) surrounding the side wall (61) of the combustion chamber (60). Also preferably, the combustion chamber (60) has an upper edge provided with a restrictive collar (71).

The diameter of the collar (71) is directly related to the dimension of the diffuser plate (62)(or to the dimension and quantity of the openings (68) of the diffuser plate (62) and the quantity of air supplied by the pump (74) through the diffuser plate (62) at near maximum speed). The collar (71) provides a positive pressure inside the combustion chamber (60) to ensure that external air does not recirculate inside the combustion chamber (60). It also limits the dimension of the piece of wood to be inserted in the combustion chamber (60).

Referring to figures 1 and 2, the air-receiving chamber (70) of the preferred embodiment illustrated has a bottom wall (76) and side walls (78) formed by an outwardly protruding circular recess shaped in the bottom wall (17) of the container (16). This recess is adapted to be covered by a dome-shaped member (79) which defines the top wall of the air-receiving chamber (70). The conduit (72) may advantageously be connected to one of the sidewalls (78) of the air receiving chamber (70) to form the air inlet thereof.

Referring now also to figure 4, the burner (14) is characterized in that it further comprises a dynamic air chamber (80) topped with the diffuser plate (62). The bottom wall (82) of the dynamic air chamber (80) comprises a rimmed aperture (84) which is adapted to be sealingly connected with an uppermost protruding portion (86) of the dome-shaped member (79) which is provided with a hole.

As can best be appreciated from figures 1 and 2, the dome-shaped member (79) as it is connected with the rimmed aperture (84) of the dynamic air chamber (80) defines a funnel-shaped inlet for the dynamic air chamber (80) in communication with the air-receiving chamber (70) for receiving an air flow of a given velocity from the air-receiving chamber (70) and

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increasing said velocity to thereby create an air turbulence zone below the diffuser plate (62). Therefore, the dynamic air chamber (80) provides dynamic combustion, even with a lower pressure from the air pump (74).

5 For the best results, the diffuser plate (62) and the bottom wall (82) of the dynamic air chamber (80) are preferably concave.

10 In operation, the source of fuel such as a piece of wood or coal is placed on the surface of the diffuser plate (62) in the combustion chamber (60) of the burner (14). Ignition of the wood is initiated by igniting a suitably positioned supply of paper or other readily combustible material. After ignition, temperature is established, the air pump (74) is turned on, and an air flow is forced through the conduit (72) into the air-receiving chamber (70), accelerated by passing through the air-funnel-shaped inlet and out through the openings (68) in the
15 diffuser plate (62). Combustion of the wood follows virtually instantaneously and is prompted by the jets of air, with identified arrows, exiting through openings (68) in the
20 diffuser plate (62).

As seen in figure 6, air under pressure in the prior art manifold provides a steady, smooth and fast moving air flow represented by dots, whereas, as seen in Figs. 1 and 2, air under pressure with the funnel-shaped air inlet of the dynamic
25 air chamber (80) provides a turbulent fast moving air flow. In other words, the dynamic air chamber adds movement or turbulence to the steady, smooth and fast moving air flow of the prior art manifold. The distance of the funnel-shaped air inlet, which is actually the hole in the dome-shaped member (79), and the diffuser plate (62) is between point five cm (,5 cm) to two point five cm (2,5 cm) with a preferred point nine five cm (,95 cm). The diameter of the hole (86) of the funnel is between one cm (1 cm) and three cm (3 cm).

30 Referring to figure 5, another version of a dynamic air chamber (80) according to the invention and which may be set under the diffuser plate (62) of a burner (14) is illustrated. In this case the funnel-shaped inlet (88) is formed in the
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rimmed aperture (84) of the bottom wall (82) of the chamber (80). This funnel-shaped air inlet (88) provides three different seatings for the air-receiving chamber (not illustrated): first (indicated as "a") on the perimeter of the bottom wall (82), second (indicated as "b") on the perimeter of the rimmed aperture (84) and third (indicated as "c") inside the funnel. The angle α is between 35° and 85° but preferably 75° to 80°. The angle α provides a long smooth flow of air. The funnel-shaped air inlet (88) allows, when used with a large conduit, a sharp low profile.

As can be appreciated, this preferred embodiment of a dynamic air chamber according to the present invention may advantageously be installed under the diffuser plate (104) of the cooking apparatus illustrated in figure 6.

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WHAT IS CLAIMED IS:

1. A burner (14) for a cooking apparatus (10) comprising:
 - a combustion chamber (60) bottomed with a diffuser plate (62), the diffuser plate (62) having an upper surface adapted to support a source of fuel, a lower surface and spaced-apart openings (68) therethrough;
 - an air-receiving chamber (70) in fluid communication with the combustion chamber (60) via the diffuser plate (62), the air-receiving chamber (70) having an air inlet (72) for connection to an air pump means (74) for forcing air through the openings (68) of the diffuser plate (62) so as to cause the air to exit on the upper surface thereof in the form of small jets of a given velocity,
 - the burner (14) being characterized in that it further comprises:
 - a dynamic air chamber (80) topped with the diffuser plate (62), the dynamic air chamber (80) having a bottom wall (82) provided with a funnel-shaped inlet (79) in communication with the air-receiving chamber (70) for receiving an air flow of a given velocity from the air-receiving chamber (70) and increasing said velocity to thereby create an air turbulence zone below the diffuser plate (62).
2. A burner (14) according to claim 1, characterized in that the diffuser plate (62) is concave.
3. A burner (14) according to anyone of claims 1 and 2, characterized in that the bottom wall (82) of the dynamic air chamber (80) is concave.
4. A burner (14) according to anyone of claims 1 to 3, characterized in that the bottom wall (82) of the dynamic air chamber (80) comprises a rimmed aperture (84) and that the burner (14) comprises a dome-shaped member (79) defining the funnel-shaped inlet, the dome-shaped member (79) having an uppermost protruding portion (86) provided with a hole and

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adapted to fit together with the rimmed aperture (84) of the bottom wall (82) of the dynamic air chamber (80).

5 5. A burner (14) according to anyone of claims 1 to 4, characterized in that the air-receiving chamber (70) comprises a top wall defined by the dome-shaped member (79).

10 6. A burner (14) according to anyone of claims 1 to 5, characterized in that the air-receiving chamber (70) includes side walls (78) and a bottom wall (76), one of the sidewalls (78) being provided with the air inlet (72) of the air-receiving chamber (70).

15 7. A burner (14) according to anyone of claims 1 to 6, characterized in that the combustion chamber (60) has a cylindrical side wall (61).

20 8. A burner (14) according to anyone of claims 1 to 7, characterized in that the combustion chamber (60) has an upper edge provided with a restrictive collar (71).

25 9. A burner (14) according to anyone of claims 1 to 8, characterized in that it comprises a shield (69) surrounding the side wall (61) of the combustion chamber (60).

10. A burner (14) according to anyone of claims 1 to 9, characterized in that the openings (68) in the diffuser plate (62) define a latticed pattern of openings (68).

30 11. A burner (14) according to anyone of claims 1 to 10, characterized in that the burner (14) is made of a heat-resistant material.

35 12. A burner (14) according to anyone of claims 1 to 11, characterized in that the burner (14) is made of stainless steel.

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13. A burner (14) according to anyone of claims 1 to 12, characterized in that it further includes the source of fuel.

5 14. A burner (14) according to anyone of claims 1 to 13, characterized in that the source of fuel is wood.

15. A cooking apparatus (10) characterized in that it comprises:

10 a burner (14) according to anyone of claims 1 to 14;
a grill assembly (12) mountable above the burner (14); and
a support to support the grill assembly (12) above the burner (14).

15 16. A cooking apparatus (10) according to claim 15, characterized in that the support comprises an open container (16) adapted to receive therein the burner (14) in an upright position, the container (16) having sidewalls (18) each having an upper edge (20) adapted to receive and support a corresponding outer edge (22) of the grill assembly (12) such
20 that the grill assembly (12) is mountable over the burner (14) enclosed in the container (16).

25 17. A cooking apparatus (10) according to claim 16, characterized in that the container (16) has a bottom wall (17) provided with an outwardly protruding circular recess adapted to be covered by the dome-shaped member (79) so as to form the air-receiving chamber (70).

Fig. 1

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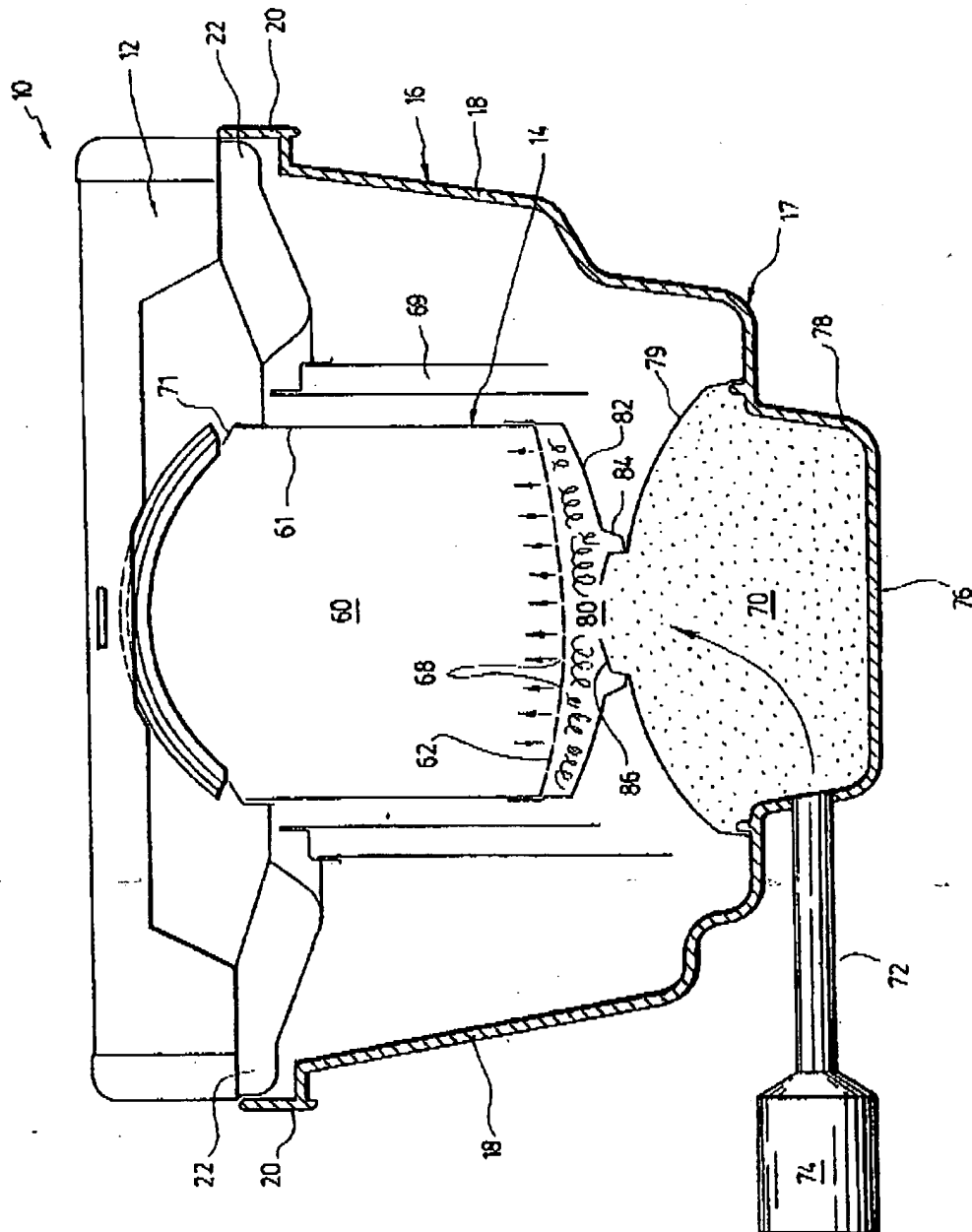


FIG. 2

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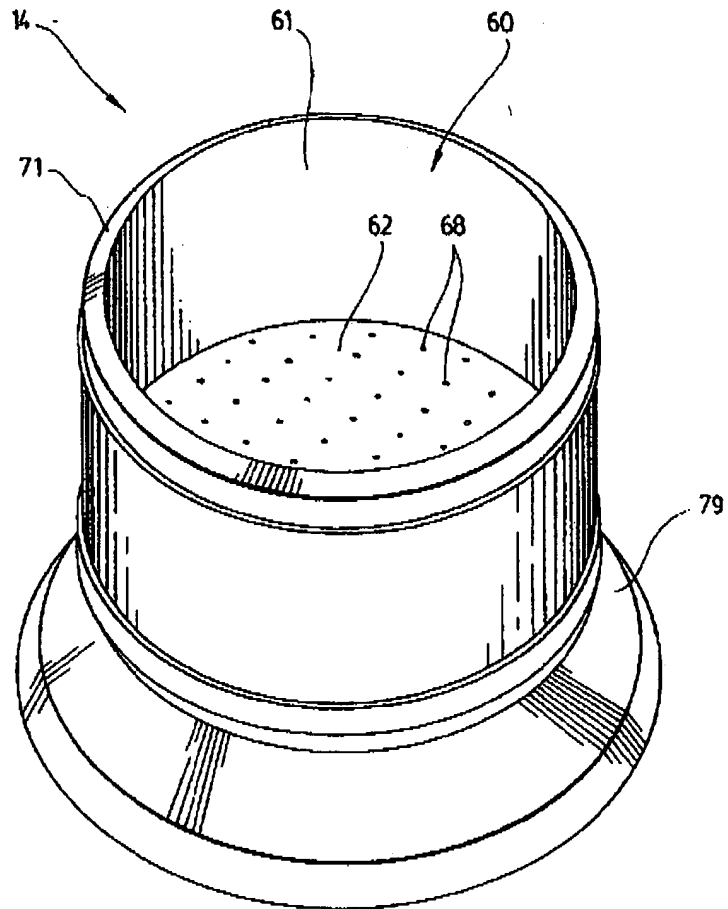


FIG. 3

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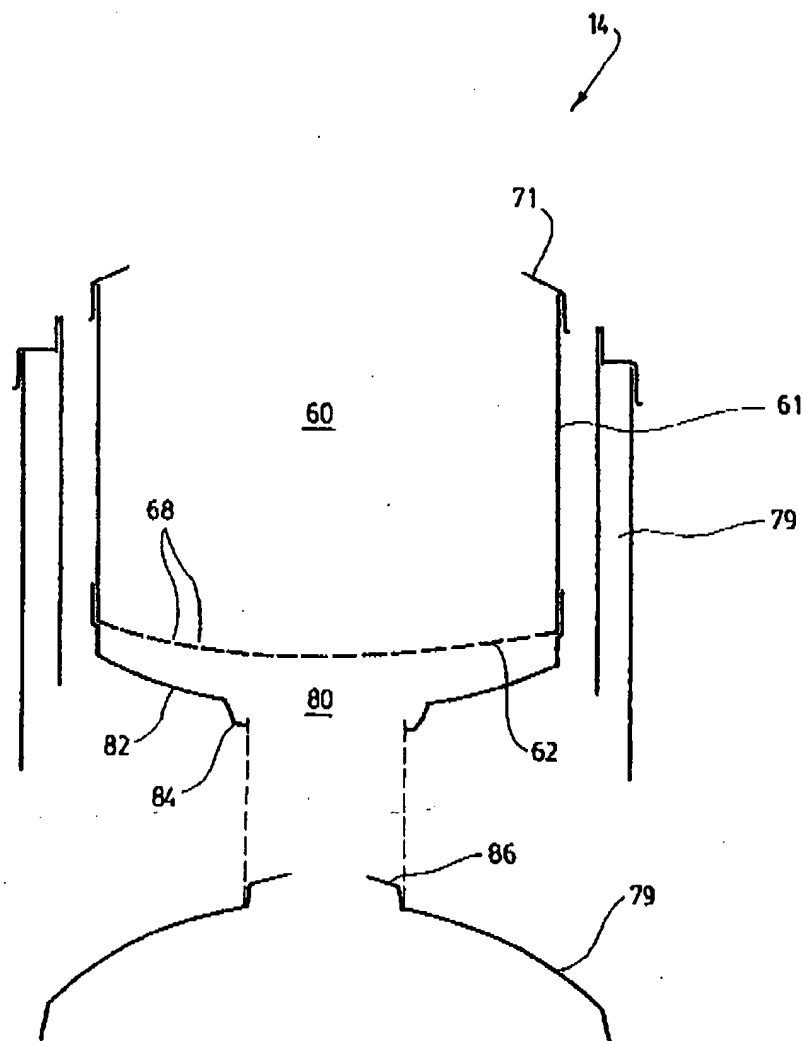


FIG. 4

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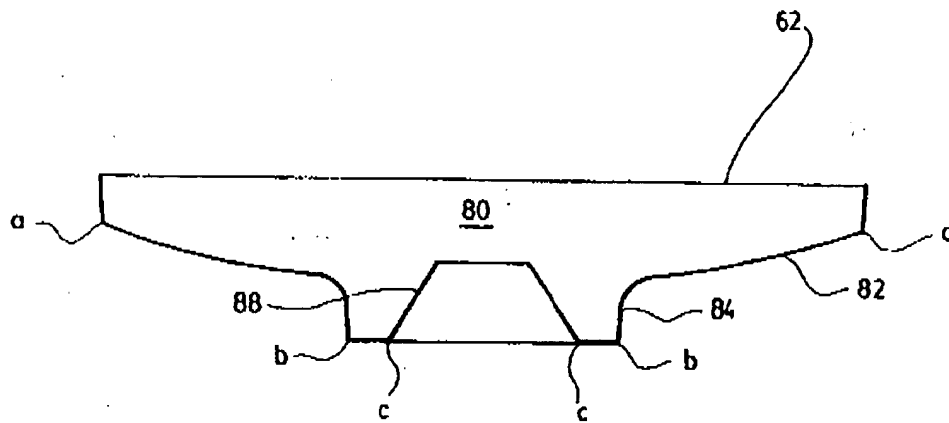


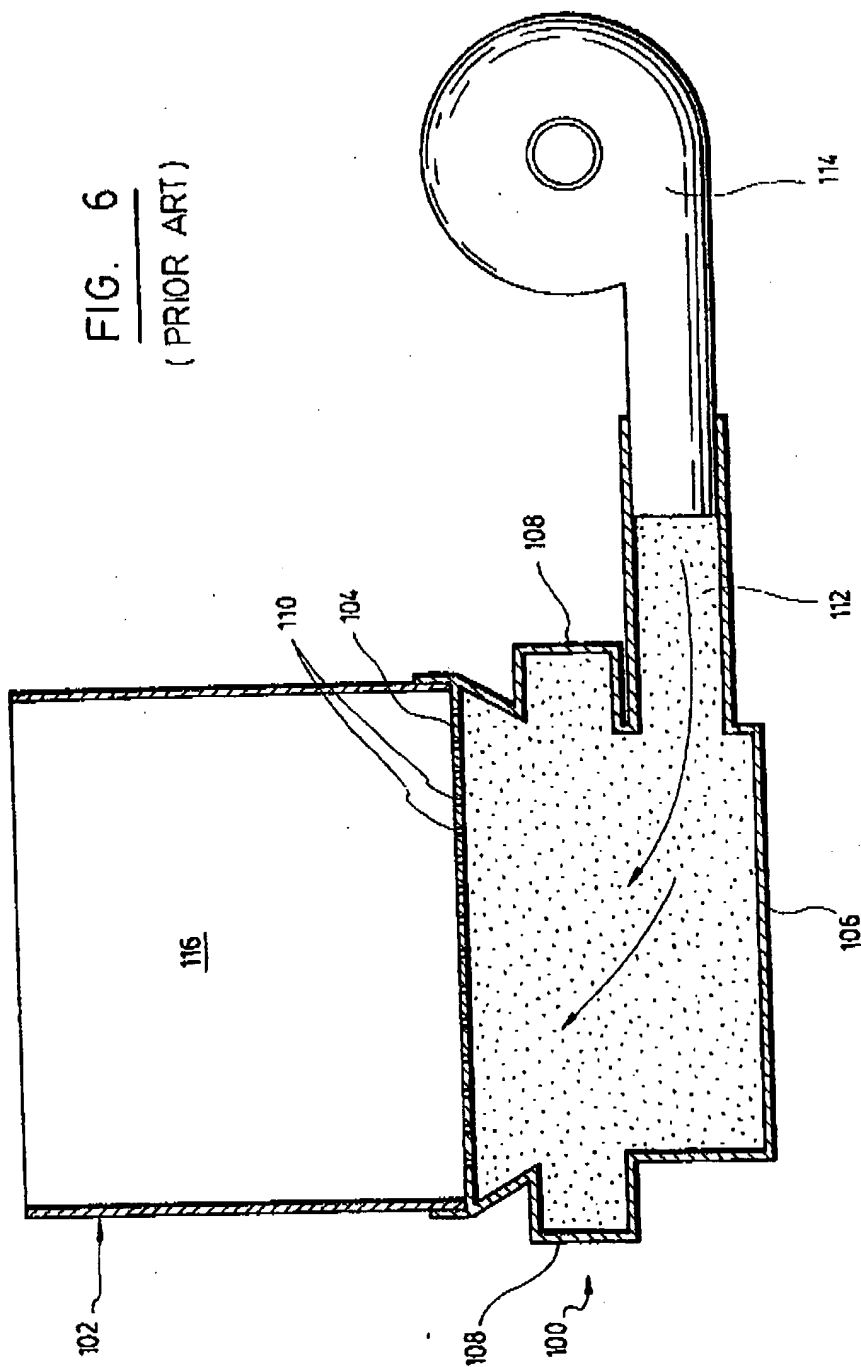
FIG. 5

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FIG. 6
(PRIOR ART)



INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 F23L1/02 F23L5/02 A47J37/07 F24B5/02

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 302 685 A (PATENAUE JEAN PIERRE ;PATENAUE GILLES JOSEPH (US)) 8 February 1989 see the whole document ---	1,9
A	US 4 384 535 A (MCKELVIE ALASTAIR H) 24 May 1983 see column 3, line 28 - line 34; figure 3 ---	1
A	US 4 924 847 A (PATENAUE JEAN-PIERRE) 15 May 1990 cited in the application see the whole document -----	1

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information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0302685 A	08-02-1989	CA 1300448 A	12-05-1992
		AU 598148 B	14-06-1990
		AU 2039188 A	09-02-1989
		CN 1032286 A, B	12-04-1989
		GR 3002120 T	30-12-1992
		JP 1097420 A	14-04-1989
		JP 2686471 B	08-12-1997
		US 4867050 A	19-09-1989
US 4384535 A	24-05-1983	US 4628834 A	16-12-1986
US 4924847 A	15-05-1990	CA 1215282 A	16-12-1986
		US 4747781 A	31-05-1988

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